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Translation of Priority Document

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Applicant(s) : Samsung Electronics Co., Ltd.

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COMMISSIONER

[ABSTRACT OF THE DISCLOSURE]

[ABSTRACT]

A routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP address is disclosed. If a home a home agent informs a correspondent station of an IP address of a foreign agent to be connected to the mobile terminal through a radio channel, the correspondent station transmits tunneling information indicating that the correspondent station can perform a reverse tunneling function to the foreign agent by consulting the IP address of the foreign agent. Thereafter, the correspondent station and the foreign agent exchange the data packet through forward and reverse tunneling.

Therefore, it is possible to perform forward tunneling from the correspondent station to the foreign agent and reverse tunneling from the foreign agent to the correspondent station, thereby previously preventing a time delay in transmitting the data packet and efficiently satisfying the security required in the correspondent station.

[REPRESENTATIVE FIGURE]

FIGURE 3

[INDEX]

Mobile IP, routing

[SPECIFICATION]

[TITLE OF THE INVENTION]

ROUTING METHOD FOR MOBILE INTERNET

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a diagram illustrating a routing operation from a correspondent station to a mobile terminal according to the prior art;

FIG. 2 is a diagram illustrating a routing operation from a mobile terminal to a correspondent station according to the prior art;

FIG. 3 is a diagram illustrating a routing operation from a correspondent station to a mobile terminal according to an embodiment of the present invention;

FIG. 4 is a diagram illustrating a tunneling operation between the correspondent station and the mobile terminal through tunneling according to an embodiment of the present invention;

FIG. 5 is a flow chart illustrating a routing procedure between a correspondent station and a foreign agent according to an embodiment of the present invention;

FIG. 6 is a diagram illustrating a format of a binding reverse information message according to an embodiment of the present invention; and

FIG. 7 is a flow chart illustrating a routing procedure in a foreign agent according to an embodiment of the present invention.

[DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT]

[OBJECT OF THE INVENTION]

[RELATED FIELD AND PRIOR ART OF THE INVENTION]

The present invention relates generally to the mobile Internet, and in particular, to a routing method using an IP (Internet Protocol) address of a mobile terminal.

FIG. 1 illustrates a routing operation from a correspondent station to a mobile terminal according to the prior art.

Referring to FIG. 1, a mobile terminal (MN) 40 having a unique mobile IP address recognizes a neighboring foreign agent (FA) 30 through a radio channel and then sends a location registration request to the foreign agent 30. The foreign agent 30 then registers a location of the mobile terminal 40 in a home agent (HA) 20. Here the foreign agent 30 recognizes locations of mobile terminals within a radio service area to register the locations in the home agent 20, and the home agent 20 connects a plurality of foreign agents to other Internet subscribers. The home agent 20 stores an IP address of the foreign agent 30 corresponding to the mobile terminal 40, thereby to indicate that the mobile terminal 40 is located in coverage of the foreign agent 30.

To transmit a data packet for IP communication to the mobile terminal 40, a correspondent station (CN) 10 in a wired network transmits to the home agent 20 a data packet whose destination address (DA) is defined as a mobile IP of the mobile terminal 40. Since the home agent 20 has a fixed IP address, the correspondent station 10 can transmit the data packet to the home agent 20

according to known IP routing. The home agent 20 confirms the destination address of the data packet and transmits the data packet to the foreign agent 30 corresponding to the mobile terminal 40. The foreign agent 30 transmits the data packet to the mobile terminal 40 through the radio channel.

FIG. 2 illustrates a routing operation from a mobile terminal to a correspondent station according to the prior art.

Referring to FIG. 2, when data packet to be transmitted to the correspondent station 10 is received from the mobile terminal 40 to the foreign agent 30, the foreign agent 30 can directly transmit the data packet to the correspondent station 10 through IP routing, without passing through the home agent 20 because the correspondent station has a fixed IP address. An incoming routing path of a data packet received at (or input to) the correspondent station 10 may be different from an outgoing routing path of a data packet transmitted from the correspondent station 10. This is because the IP routing transmits the data packet through different nodes at every transmission. However, a router of the correspondent station 10 has a security function of comparing a port number of the incoming routing path with a port number of the outgoing routing path, and refusing the received data packet if they are different from each other. In order to solve this security problem, the foreign agent 30 must transmit the data packet form the mobile terminal 40 only through the home agent 20.

When the data packet is transmitted through the home agent 20 as stated

above, it must pass through a plurality of routing nodes, including the home agent 20, so that there occurs a time delay and a communication service is not properly provided.

[SUBSTANTIAL MATTER OF THE INVENTION]

It is, therefore, an object of the present invention to provide a method for directly transmitting data packets received from a mobile terminal to a correspondent station through tunneling from a foreign agent wirelessly connected to the mobile terminal having a mobile IP address.

It is another object of the present invention to provide a method for transmitting tunneling information indicating that a correspondent station can perform a reverse tunneling function, from the correspondent station to a foreign agent.

In accordance with one aspect of the present invention, there is provided a routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP (Internet Protocol) address, comprising the steps of informing, in a home agent, a correspondent station which is to transmit a data packet for IP communication to the mobile terminal of an IP address of a foreign agent to be connected to the mobile terminal through a radio channel, and transmitting tunneling information indicating that the correspondent station can perform a reverse tunneling function to the foreign agent from the correspondent station by consulting the IP address of the foreign agent.

In accordance with another aspect of the present invention, there is provided a routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP address, comprising the steps of transmitting a data packet for IP communication with the mobile terminal from a correspondent station to the home agent in which an IP address of a foreign agent to be connected to the mobile terminal through a radio channel is registered, transmitting the data packet from the foreign agent to the mobile terminal through the radio channel upon receipt of the data packet from the home agent, transmitting the IP address of the foreign agent from the home agent to the correspondent station, transmitting tunneling information indicating that the correspondent station can perform a reverse tunneling function to the foreign agent by consulting the IP address of the foreign agent, and adding in the foreign agent a tunneling IP header for reverse tunneling to the data packet received from the mobile terminal by consulting the tunneling information and transmitting the header-added data packet to the correspondent station.

In accordance with further another aspect of the present invention, there is provided a routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP address, comprising the steps of when a correspondent station transmits a data packet to which a tunneling IP header for forward tunneling is added to a foreign agent to be connected to the mobile terminal through a radio channel, transmitting the data packet from the foreign agent to the mobile terminal, and upon receipt of the data packet for IP

communication with the correspondent station from the mobile terminal, adding in the foreign agent a tunneling IP header for reverse tunneling to the received data packet and transmitting the header-added data packet to the correspondent station.

In accordance with still another aspect of the present invention, there is provided a routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP address, comprising the steps of receiving, at a foreign agent connected to the mobile terminal through a radio channel, a data packet for IP communication with a correspondent station from the mobile terminal, determining in the foreign agent whether the correspondent station can perform reverse tunneling by consulting previously stored tunneling information, adding a tunneling IP header for reverse tunneling to the data packet and transmitting the header-added data packet to the correspondent station, if the correspondent station can perform the reverse tunneling, and transmitting the data packet to the home agent, if the correspondent station cannot perform the reverse tunneling.

[CONSTRUCTION AND OPERATION OF THE INVENTION]

A preferred embodiment of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

FIG. 3 illustrates a routing operation from a correspondent station to a mobile terminal according to an embodiment of the present invention. For convenience of explanation, it will be assumed that in the home agent 20 is previously registered an IP address of the foreign agent 30 corresponding to the mobile terminal 40.

Referring to FIG. 3, to transmit a data packet for IP communication to the mobile terminal 40, the correspondent station 10 transmits to the home agent 20 a first (or initial) data packet for IP communication with the mobile terminal 40 (①). A destination address DA of the first data packet is defined as a unique mobile IP address of the mobile terminal 40, and a source address SA of the first data packet is defined as an IP address of the correspondent station 10.

The correspondent station 10 is a common node in an external network, which intends to communicate with the mobile terminal 40, and can be a workstation or a personal computer having a fixed IP address, or another mobile terminal having a mobile IP address. Although the invention will be described with reference to an example where the correspondent station 10 directly controls transmission of the data packet, it will be understood by those skilled in the art that transmission of the data packet can be actually controlled by a default router corrected to the correspondent station 10.

The home agent 20 detects a destination address of the received data packet and transmits the data packet to the foreign agent 30 connected to the

mobile terminal 40 having the corresponding IP address (320), and the foreign agent 30 then transmits the data packet to the mobile terminal 40 through a radio channel (②).

The home agent 20 adds an additional IP header to the data packet transmitted to the foreign agent 30, and the IP header includes a destination address defined as an IP address of the foreign agent 30 and a source address defined as an IP address of the home agent 20. The data packet using the additional IP header is known as tunneling. Therefore, the additional IP header is called a "tunneling IP header". For tunneling, a transmitter must have an additional function of the tunneling IP header and a receiver must have an analyzing function of the tunneling IP header. Unlike the general IP routing, the tunneling uses the tunneling IP header having IP addresses of an intermediate transmitter and an intermediate receiver, and the final destination is determined at the intermediate receiver by analyzing the tunneling IP header.

As long as the mobile terminal 40 does not move to a service area of a foreign agent in another area, the data packet transmitted to the mobile terminal 40 must be always transmitted to the foreign agent 30. In this case, if the correspondent station 10 knows the IP address of the foreign agent 30, it is possible to perform forward tunneling from the correspondent station 10 to the foreign agent 30.

Therefore, the home agent 20 transmits the data packet to the foreign

agent (②) and at the same time, transmits the IP address of the foreign agent 30 to the correspondent station 10 (③). Then, as shown in FIG. 4, the correspondent station 10 adds the subsequent data packets to be transmitted to the mobile terminal 40 to the additional IP header, i.e., the tunneling IP header, whose destination address is defined as the IP address of the foreign agent 30, such that the subsequent data packets are directly transmitted to the foreign agent 30 through the forward tunneling, without passing through the home agent 20. The direct transmission of the data packet referred to in this specification should be understood as not the actual direct transmission but the transmission without passing through the home agent, that is, the tunneling.

Meanwhile, in order to enable the forward tunneling from the correspondent station 10 to the foreign agent 30 in addition to the security function of the correspondent station 10, reverse tunneling from the foreign agent 30 to the correspondent station 10 must be available. To this end, the foreign agent 30 must previously know whether the correspondent station 10 can perform the reverse tunneling function. If the correspondent station 10 can perform only the forward tunneling function and can not perform the reverse tunneling function, it can not analyze the tunneling IP header of the data packet received from the foreign agent 30.

Therefore, upon receiving the IP address of the foreign agent 30 from the home agent 20 (③), the correspondent station 10 transmits tunneling information indicating that it can perform the tunneling function, to the foreign agent 30 (④).

If the foreign agent 30 determines that the correspondent station 10 can perform the reverse tunneling function, based on the tunneling information received from the correspondent station 10, the foreign agent 30 transmits the subsequent data packets to the correspondent station 10 by reverse tunneling. If, however, it is determined that the correspondent station 10 cannot perform the reverse tunneling function, the foreign agent 30 transmits the subsequent data packets to the correspondent station 10 through the home agent 20 as in the prior art.

A routing operation at each node between the correspondent station and the mobile terminal according to the present invention will be described hereinafter.

FIG. 5 illustrates a procedure for storing routing information according to an embodiment of the present invention.

Referring to FIG. 5, in step S110, the correspondent station 10 transmits a first data packet to be transmitted to the mobile terminal 40 to the home agent 20 through IP routing. At the same time, the correspondent station 10 transmits to the home agent 20 a binding request message for requesting an address of the foreign agent 30 which can connect a radio channel with the mobile terminal 40. Although a procedure for transmitting the binding request message is included in the embodiment of the present invention, the binding request message may not be transmitted in another embodiment of the present invention. A destination address of the IP header of the first data packet transmitted from the

correspondent node 10 is defined as a mobile IP address of the mobile node 40.

As mentioned above, in the home agent 20 is previously registered an IP address of the foreign agent 30 to be connected to the mobile terminal 40 through the radio channel. Thus, in step S120, the home agent 20 transmits the first data packet to the foreign agent 30, and the foreign agent 30 then provides the first data packet to the mobile terminal 40.

To enable the forward tunneling, the home agent 20 transmits a binding update message indicating an IP address of the foreign agent 30 to the correspondent station 10, in step S130. The correspondent station 10 then sends a binding acknowledge message to the home agent 20 in response to the binding update message. If the binding request message is not transmitted in another embodiment of the present invention, the binding acknowledge message will not be transmitted.

The correspondent station 10 transmits a binding reverse information message including the tunneling message indicating that it can perform reverse tunneling, by consulting the IP address of the foreign agent 30, in step S140. The binding reverse information message has a format shown in FIG. 6, which has the 1-bit tunneling information R indicating whether the correspondent station 10 can perform reverse tunneling. In FIG. 6, the bit R=1 indicates that the correspondent station 10 can perform reverse tunneling, while the bit R=0 indicates that the correspondent station 10 cannot perform reverse tunneling.

Further, a bit M and a bit G indicate Minimal Encapsulation and GRE Encapsulation, respectively, which are different tunneling techniques. In addition, a Lifetime field indicates the time when the foreign agent 30 and the correspondent station 10 must store the tunneling information.

In step S150, the correspondent station 10 stores information indicating that it has already transmitted the tunneling information to the foreign agent 30, such that it is not required to retransmit the tunneling information when the correspondent station 10 IP-communicates with the foreign agent 30 in the same area again during the lifetime which is a constant time determined by the binding reverse information message.

In step S160, the foreign agent 30 stores the tunneling information received from the correspondent station 10, such that it can perform reverse tunneling even without retransmitting the tunneling information, when the foreign agent 30 IP-communicates with the correspondent station 10 again during the lifetime, which is a constant time determined by the binding reverse information message.

FIG. 7 illustrates a routing operation in a foreign agent according to an embodiment of the present invention.

Referring to FIG. 7, upon receipt of a data packet for IP communication with the correspondent station 10 from the mobile terminal 40 in step S210, the

foreign agent 30 searches the previously stored tunneling information and determines in step S220 whether the correspondent station 10 can perform reverse tunneling.

If the correspondent station 10 cannot perform reverse tunneling or there exists no tunneling information stored for the correspondent station 10, the foreign agent 30 transmits the data packet to the home agent 20 through tunneling in step S230. The home agent 20 then transmits the data packet to the correspondent station 10 through IP routing.

Otherwise, if the correspondent station 10 can perform reverse tunneling, the foreign agent 30 encapsulates the data packet with the tunneling IP header for reverse tunneling and transmits the encapsulated data packet to the correspondent station 10 in step S240. A destination address of the tunneling IP header is defined as the IP address of the correspondent station 10 and a source address of the tunneling IP header is defined as the IP address of the foreign agent 30.

The correspondent station 10 analyzes the tunneling IP header of the received data packet and extracts the packet data.

While the invention has been shown and described with reference to a certain preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended

claims. For example, in a procedure for transmitting the tunneling information indicating that the corresponding station can perform the reverse tunneling function to the foreign agent, if all the correspondent stations can perform the reverse tunneling function, it is not necessary to transmit the tunneling information. That is, after the first packet data is exchanged, the foreign agent will always transmit the next data packets to the correspondent station through the reverse tunneling.

As another example, the correspondent station may receive the binding update message from the home agent for several reasons such as a handoff. In any case, once the correspondent station knows the IP address of the foreign agent, it transmits the tunneling information to the corresponding foreign agent. Therefore, the scope of the disclosed invention is not to be restricted except in the spirit of the appended claims.

[EFFECTS OF THE INVENTION]

The invention has the following advantages. By enabling both the forward tunneling from the correspondent station to the foreign agent and the reverse tunneling from the foreign agent to the correspondent station, it is possible to prevent a time delay in transmitting the data packets and efficiently satisfy the security required in the correspondent station. In addition, since the tunneling IP header added to the data packet transmitted through tunneling has an IP address of the intermediate transmitter, not an IP address of the initial transmitter or the final transmitter, the IP address of the initial transmitter of the

final transmitter is not leaked out even though the data packet is hacked at any node (or router) on the transmission path.

[PATENT CLAIMS]

1. A routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP (Internet Protocol) address, comprising the steps of:

informing, in a home agent, a correspondent station which is to transmit a data packet for IP communication to the mobile terminal of an IP address of a foreign agent to be connected to the mobile terminal through a radio channel; and

transmitting tunneling information indicating that the correspondent station can perform a reverse tunneling function to the foreign agent from the correspondent station by consulting the IP address of the foreign agent.

2. The routing method as claimed in claim 1, further comprising the step of adding in the foreign agent a tunneling IP header for reverse tunneling to the data packet received from the mobile terminal by consulting the tunneling information and transmitting the header-added data packet to the correspondent station.

3. The routing method as claimed in claim 1, further comprising the steps of:

adding in the correspondent station a tunneling IP header for forward tunneling to the data packet to be transmitted to the mobile terminal by consulting the IP address of the foreign agent and transmitting the header-added data packet to the foreign agent; and

receiving at the foreign agent the data packet and transmitting the received data packet to the mobile terminal.

4. The routing method as claimed in any one of claims 1 to 3, further comprising the step of storing information indicating that the tunneling information has been transmitted to the foreign agent, in the correspondent station for a predetermined time.

5. The routing method as claimed in any one of claims 1 to 3, further comprising the step of storing the tunneling indication information received from the correspondent station in the foreign agent for a predetermined time.

6. A routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP address, comprising the steps of:

transmitting a data packet for IP communication with the mobile terminal from a correspondent station to the home agent in which an IP address of a foreign agent to be connected to the mobile terminal through a radio channel is registered;

upon receipt of the data packet from the home agent, transmitting the data packet from the foreign agent to the mobile terminal through the radio channel;

transmitting the IP address of the foreign agent from the home agent to

the correspondent station;

transmitting tunneling information indicating that the correspondent station can perform a reverse tunneling function to the foreign agent by consulting the IP address of the foreign agent; and

adding in the foreign agent a tunneling IP header for reverse tunneling to the data packet received from the mobile terminal by consulting the tunneling information and transmitting the header-added data packet to the correspondent station.

7. A routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP address, comprising the steps of:

when a correspondent station transmits a data packet to which a tunneling IP header for forward tunneling is added to a foreign agent to be connected to the mobile terminal through a radio channel, transmitting the data packet from the foreign agent to the mobile terminal; and

upon receipt of the data packet for IP communication with the correspondent station from the mobile terminal, adding in the foreign agent a tunneling IP header for reverse tunneling to the received data packet and transmitting the header-added data packet to the correspondent station.

8. A routing method for mobile Internet to provide an Internet service to a mobile terminal having a unique mobile IP address, comprising the steps of:

receiving, at a foreign agent connected to the mobile terminal through a radio channel, a data packet for IP communication with a correspondent station from the mobile terminal;

determining in the foreign agent whether the correspondent station can perform reverse tunneling by consulting previously stored tunneling information;

adding a tunneling IP header for reverse tunneling to the data packet and transmitting the header-added data packet to the correspondent station, if the correspondent station can perform the reverse tunneling; and

transmitting the data packet to the home agent, if the correspondent station cannot perform the reverse tunneling.

9. The routing method as claimed in claim 8, wherein the tunneling information is received from the correspondent station.

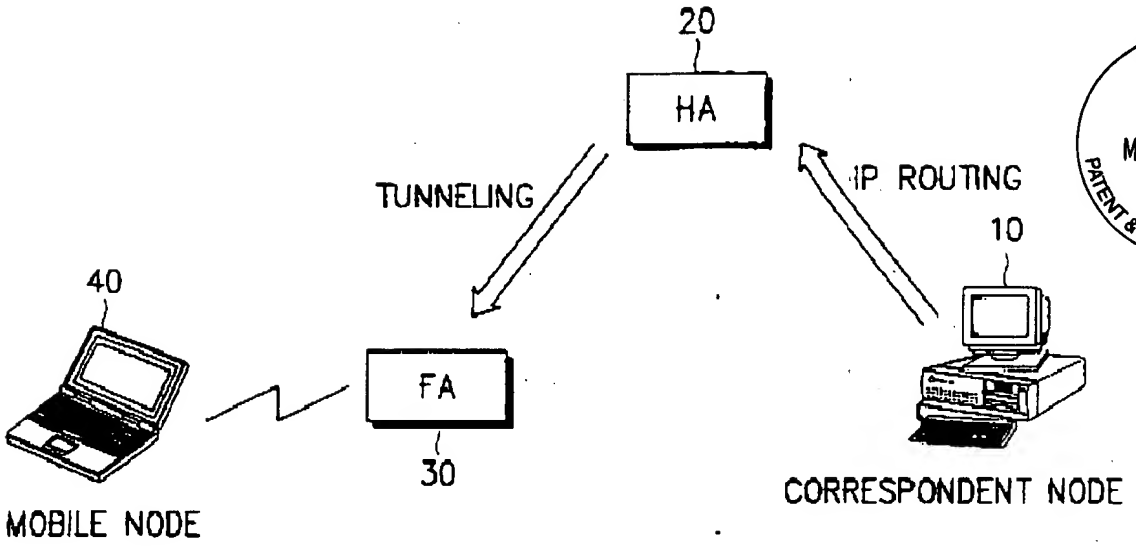

FIG. 1

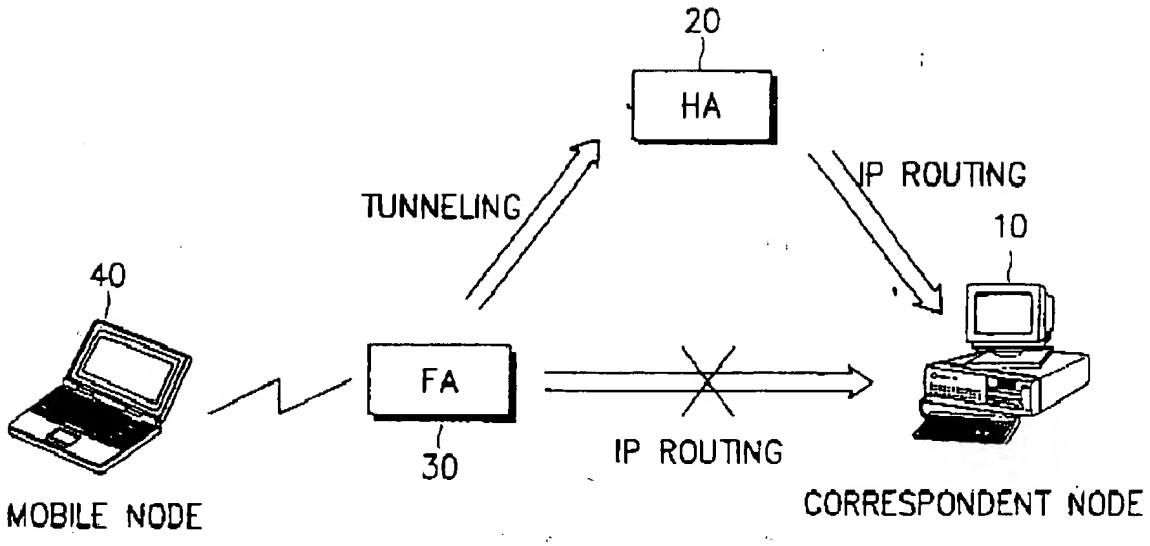

FIG. 2

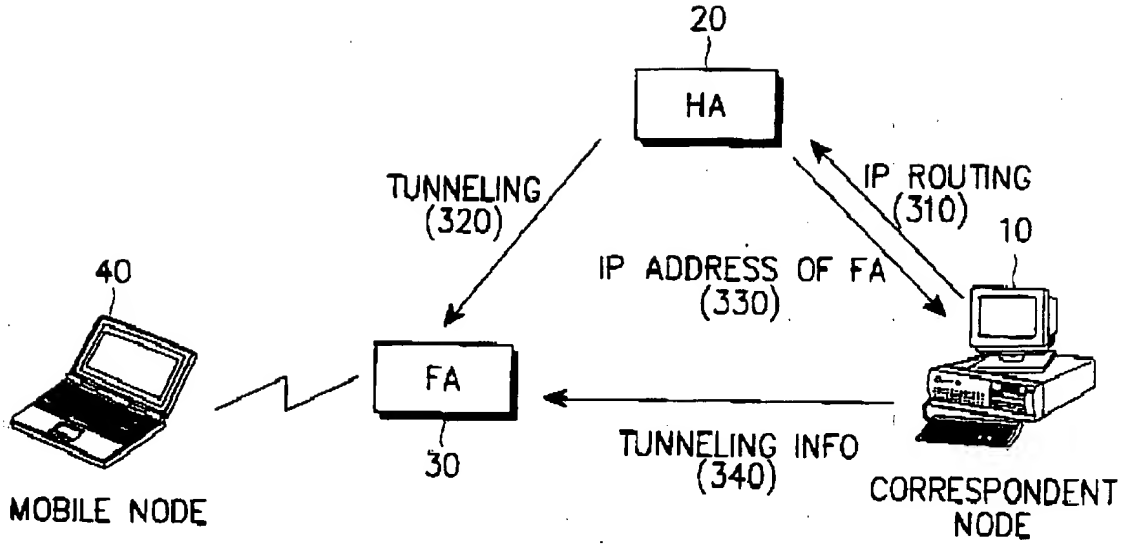
20
HA
TUNNELING
(320)
IP ROUTING
(310)
10
40
IP ADDRESS OF FA
(330)
FA
30
TUNNELING INFO
(340)
MOBILE NODE
CORRESPONDENT
NODE

FIG. 3

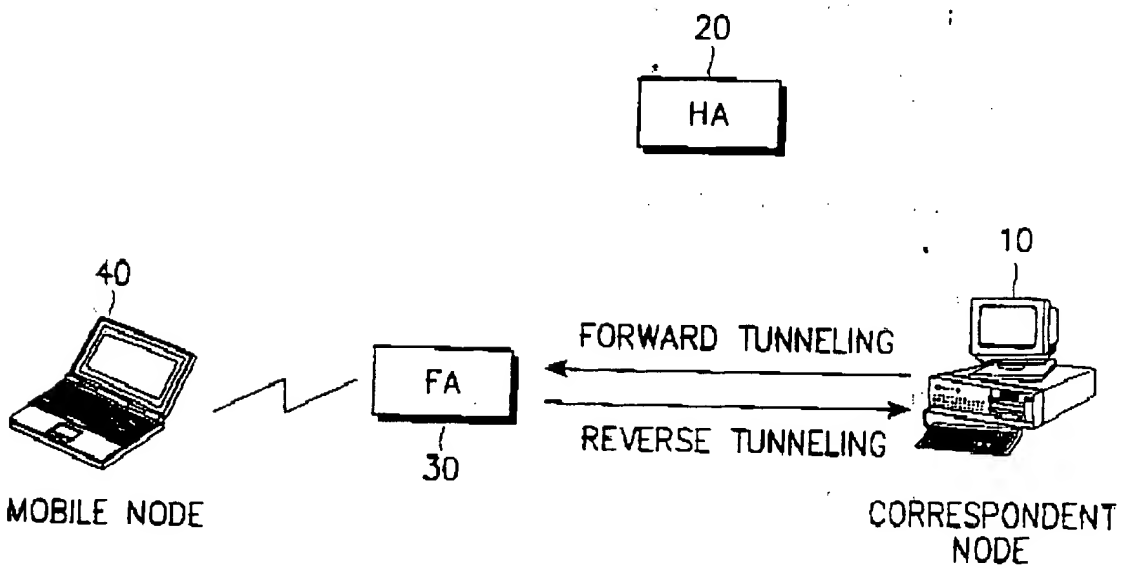
20
HA
10
40
FORWARD TUNNELING
FA
REVERSE TUNNELING
30
MOBILE NODE
CORRESPONDENT
NODE

FIG. 4

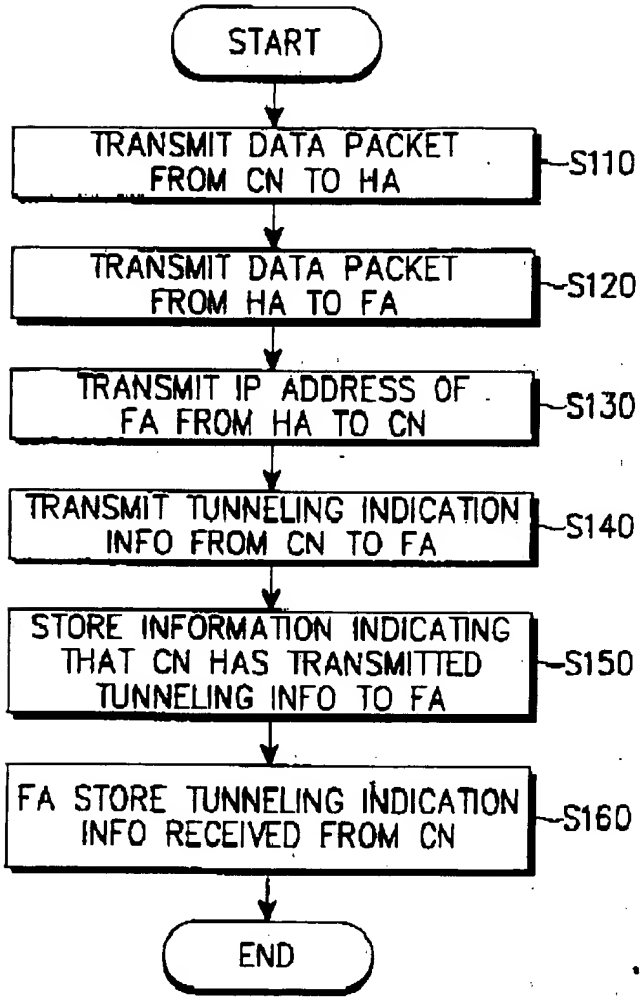
START
TRANSMIT DATA PACKET FROM CN TO HA
S110
TRANSMIT DATA PACKET FROM HA TO FA
S120
TRANSMIT IP ADDRESS OF FA FROM HA TO CN
S130
TRANSMIT TUNNELING INDICATION INFO FROM CN TO FA
S140
STORE INFORMATION INDICATING THAT CN HAS TRANSMITTED TUNNELING INFO TO FA
S150
FA STORE TUNNELING INDICATION INFO RECEIVED FROM CN
S160
END

FIG. 5

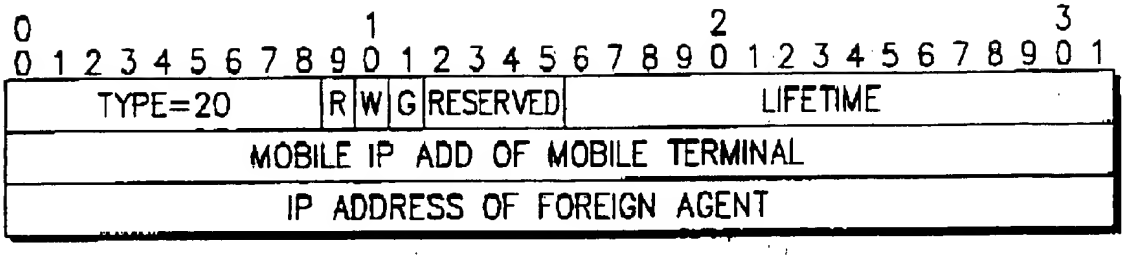
0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
TYPE=20
R
W
G
RESERVED
LIFETIME
MOBILE IP ADD OF MOBILE TERMINAL
IP ADDRESS OF FOREIGN AGENT

FIG. 6

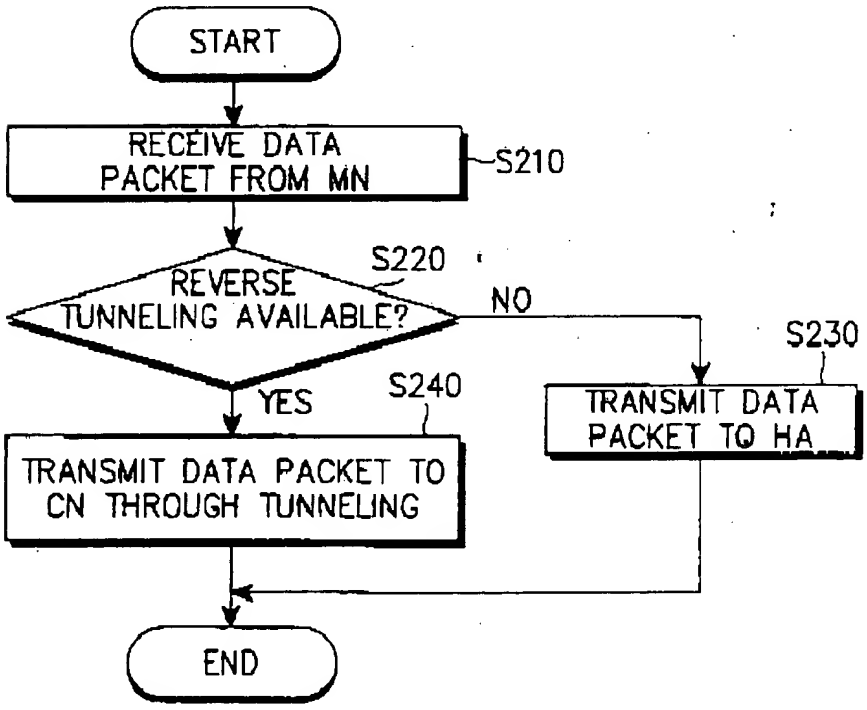
START
RECEIVE DATA PACKET FROM MN
S210
S220
REVERSE TUNNELING AVAILABLE?
NO
S230
YES
S240
TRANSMIT DATA PACKET TO HA
TRANSMIT DATA PACKET TO CN THROUGH TUNNELING
END

FIG. 7